

Indiana Partners for Pollution Prevention

Industrial Water Conservation and
Reuse Solutions
Conserve Water, Save Energy

Danco

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Danco

- Danco is a 25 year strong, veteran owned business that was built supplying cooling tower, boiler and waste water pretreatment chemicals.
- Design/build and modification of waste water treatment facilities
- Over the past 5 years, Danco has added and quickly grew a commitment to Water Conservation and Water Reuse.
 - Direct impact on Sustainability, ISO 14001 initiatives, LEED Credits/Fiscally Responsible/Energy savings/Chemical Reduction
 - Vital to the future of Indiana's economic grow

As a sustainability consultant, I take pride in helping industry find new cost savings with the goal of exceeding water and energy reduction goals. Our noninvasive prequalification process affords us the opportunity to build a business case to explore whether or not we have a fiscally responsible opportunity for impact

Fiscally Responsible AND Sustainable?

- Yes, they co-exist, and very well in the proper application!
- Explore and prioritize solutions that offer more than one benefit:
 - Water Conservation AND Energy Savings - These go hand in hand
 - Water Conservation AND Asset Protection
 - Water Conservation coupled with Reuse
 - Water Conservation coupled with Chemical Reduction
- So many new water treatment and filtration technologies are being vetted and proven each year.
- In our case, we have the flexibility to consider, review, internally vet, track and prove various technologies to help meet our clients sustainability goals

Baseline/Water Balance

- Process water usage baselines are critical in the business case building process..., as we all know, accuracy is KEY to building reconcilable, sustainable business cases
- In some cases, this can be done without incurring the initial expense of purchasing and installing multiple flow meters for each process
- An extremely detailed and comprehensive review of your organizations water consumption and generates a quantitative report detailing its findings and recommendations.
- This process provides a macro assessment and then breaks down the findings on a micro level by department and then by process.
- This study literally provides tracking and usage for every gallon of water your organization purchased, where it was consumed, its current quality, how it is currently being managed, its potential for reuse and finally, the discharge impacts - compliance and cost.

Main to Drain - Utility expense

- Water and Sewer charges are normally just a portion while working to building businesses cases
 - Must identify and quantify all the other variables that are impacting water expense
 - Regeneration of softeners - brine impact
 - RO Reject impact
 - Cooling tower or evaporative condenser blowdown
 - Boiler blow down
 - Which water users are also impacting waste water treatment or haul away expenses?

Cooling Towers

- Cooling towers/evaporative condensers accomplish cooling in refrigeration, air conditioning, and process heat removal by water evaporation; providing 8 to 15°F of cooling.
- About 50% of the water in a cooling tower evaporates which requires constant makeup water.

Why treat the water?

- Maintain design operating efficiency
 - Reduce equipment maintenance expenses
 - Reduce operating costs
 - Health and safety concerns
 - Prolong the life of mechanical assets
-
- There have been several products over the past 10+ years that claim to save water and eliminate the needs for chemicals.

High Efficiency Softening System Ion Polishing (HES)

- WCTI is the patent holder on a technology that is enormously impacting industry, data centers and hospitals
- Born on the west coast 11 years ago due to water challenges
- Based on 100 years of proven research; Silica based approach makes it as **GREEN** as it can get!
- Multi-faceted impacts
 - ✓ Water Conservation
 - ✓ Elimination or reduction of hazardous chemicals
 - sulfuric acid, corrosion inhibitors, biocides
 - ✓ Asset protection that exceeds industry standards
 - ✓ Energy savings
 - ✓ Short ROI / year over year cost savings

Chemical Reduction

HES does not require the use of conventional cooling tower chemicals - sulfuric acid and scale inhibitors

1. The use of 2 softener columns that work together during regeneration eliminates ANY chance of scaling.

➤ ***No need for scale inhibitors***

2. HES uses a GREEN naturally occurring silica solution along with trace amounts of tolytriazole to achieve corrosion protection.

➤ ***No need for conventional corrosion chemistry***

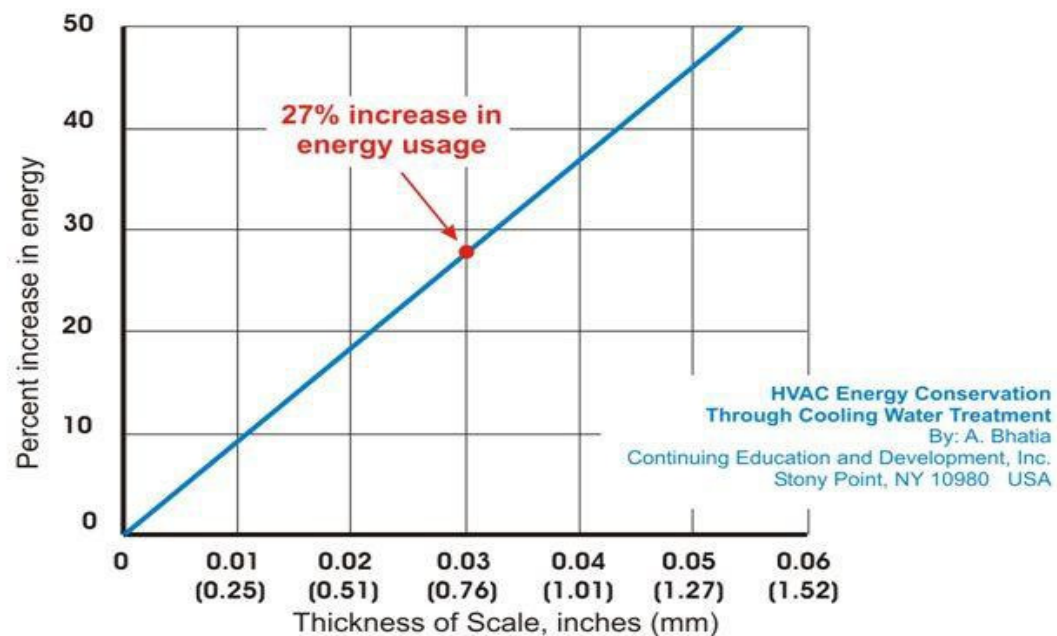
3. Once the system has been cycled up the PH (9.8) and high TDS (>10,000) of the system make the water "biostatic", which means bacteria struggle to grow and thrive

➤ ***Eliminates or reduces need for biocides***

4. ***Increase the cycles of concentration – 12-20***

What are scale and biofilm costing your organization?

Scale thickness and increase in energy usage



Effect of Condenser Tube Scale (CaCO_3) on Energy Consumption

The graph shows that a calcium carbonate scale thickness of 0.03 inches (0.76 mm) represents an increase of 27% in electrical energy compared to the same unit free of scale.

Biofilm/slime can cause an increase in energy usage of up to 4 times that of calcium carbonate for the same thickness of buildup.

27% energy loss = 0.76 mm scale



Microscopic view of three cuboidal grains of ordinary table salt (sodium chloride or NaCl). All three grains are just over one millimeter in length (red bar). Grains of table salt vary slightly in size, but three average grains stacked together adds up to approximately one mm. If three grains equal one millimeter in length, then a single grain is approximately 0.3 mm or 0.03 cm on a side.

HES at work!



The HES Ion Polishing System Distributed by Danco Corp

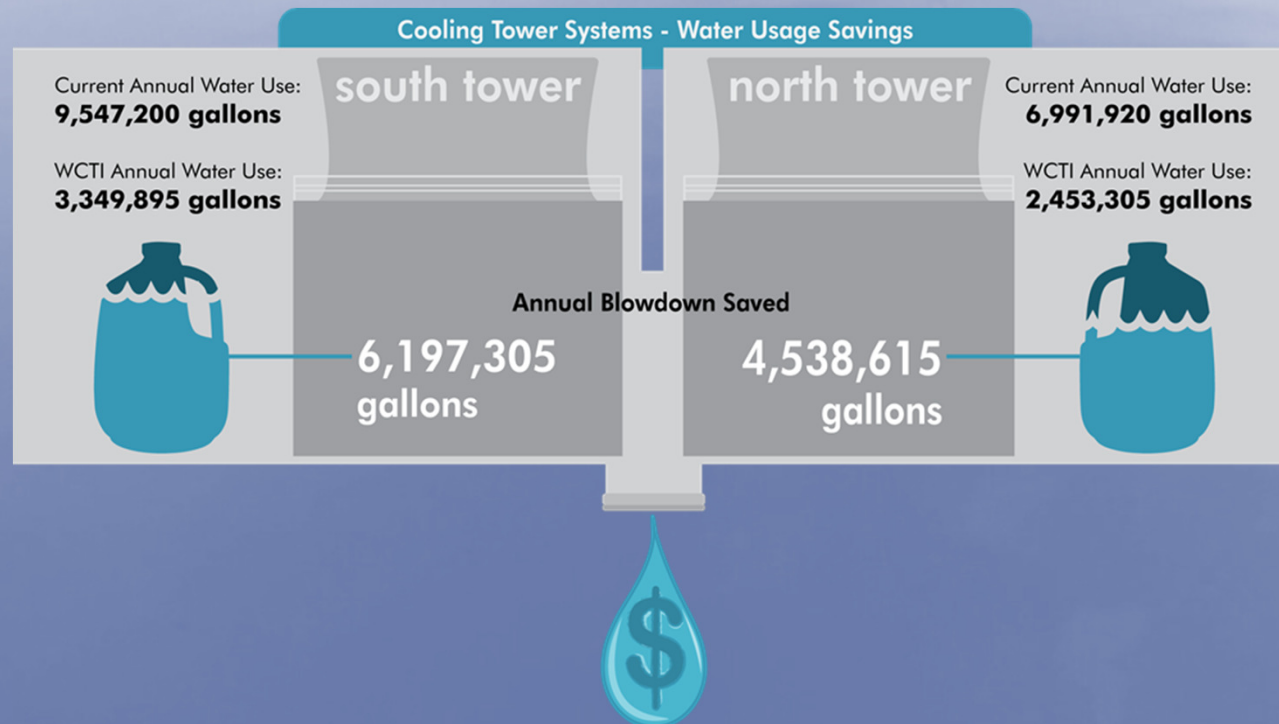
This is a pre-conditioning and water treatment system that removes scale forming ions from tower make-up. The only materials used are salt and custom silica blend - both an inexpensive and sustainable natural commodities. This system will help protect your expensive mechanical systems as well as the people your facility serves.

Benefits:

- Typically reduces total treatment cost by 50% or greater
- New Industry Standard for Corrosion Protection (<0.1 MPY for mild steel, copper, galvanized, aluminum)
- Non-toxic chemistry and cost effective elimination of discharge
- No chemical handling & storage
- Reduced testing and operator time
- Ideal for high silica or reuse (wastewater) makeup source waters
- Eliminates "bleed & feed" water wastage and chemical costs

10,000,000 gallons annually

Lake Central Impact statement inserted here




Forecasted water savings with both towers online with HES is

\$57,032 annually

Reduction in required water treatment chemicals can be assumed
at another \$25,000

Operation Clean Up



Filtration & Soft Water

Cost \$45,000 to decon and clean #1 plate and frame heat exchanger. With a combination of filtration and soft water saved this school from needing to have #2 plate and frame cleaned. Resulting in saving \$90,000.

Your system(s) over worked?



Energy Usage Savings

Prior to HES, this school was operating on (2) 100 horsepower motors on the south tower to keep up with summer demands.

But now, they are down to only 1 motor & still keeping up with demand and saving money.

Proof is in the coupons

Coupon Evaluation

 C1010 MILD STEEL
D40681 .1664 (Mpy) after 98 days

 CDA110 COPPER
A35139 .0491 (Mpy) after 98 days

Acceptable industry average for corrosion rate for coupons range from 1.5 - 3 Mpy.

Biostatic Tower Water



Health & Safety

We are
Legionella fighters!

We naturally increase the pH of water to about 9.8 creating an environment where bacteria cannot survive. This greatly reduces or eliminates the need for harmful biocide chemicals.

Water technology saving your facility \$?

Calculations show that this school will realize an estimated

\$306,232 in savings in year one

thanks to the HES Ion Polishing system and proper maintenance of the closed loops system

Talking significant gallons...

CASE STUDY #1 — large engine manufacture in southern Indiana

- Danco installs 2 HES systems at 2 different facilities and collectively conserved 16,400,000 gallons (40% reduction) in the first year. Just installed a third system

CASE STUDY #2 — UNIVERSAL STUDIOS

- HES conserves 78,000,000 gallons* annually.

CASE STUDY #3 - BOEING

- HES conserves 7,600,000 gallons annually (40% reduction). HES in multiple other Boeing facilities

CASE STUDY #4 — MIDWEST DATA CENTER

- HES conserves 40,000,000 gallons annually

- WCTI has a plethora of technical and application specific resources for review and further understanding



Subtitle Here

MEMBRANE CAPACITIVE DEIONIZATION (CAPDI)

Membrane Capacitive Deionization (CapDI)

- Founded in the Netherlands 7 years ago and operational in 19 countries
- Chemical free, low-cost and environmentally friendly alternative to softening, RO and deionization systems.
- Uses patented membrane technology along with low voltage electrical charge to selectively capture and retain anions and cations based on the make up of the feed water.
- 10-12% of the energy usage vs a standard RO unit
- Remote monitoring option ensuring requested recovery, not to mention, an excellent project reconciliation tool
- Voltea's CapDI technology has been recognized by numerous awards

Voltea Awards

2010: Winner Technology innovation award

- Global water summit, Paris

2010: Selected most promising venture

- Volkskrant

2010: Ranked 3rd as most creative company in Europe

- CNBC Business

2011: Listed top 50 water technology

- Artemis project

2011: Listed top 100 Cleantech company

- Cleantech group from 4274 nominations

2011: Nomination Herman Wijffels prijs

2012: Listed top 100 Cleantech company

2013: Winner Blue Truffle Award - Bluetech Forum, Amsterdam

2013: World Economic Forum - Technology Pioneer

2014: Voltea presented to Dutch parliament by minister Schultz van Haegen as a successful start-up company in water technology

2015: Semi finalist Accenture innovation awards 2015

What does CapDI remove?

In the early 1800s Michael Faraday introduced the words **anion** for a negatively charged ion, and **cation** for a positively charged one. In Faraday's nomenclature, **cations** were named because they were attracted to the cathode in a galvanic device and anions were named due to their attraction to the anode

Cations (+) attracted to Cathod

Calcium (mg/L as Ca^{2+})

Magnesium (mg/L as Mg^{2+})

Calcium Hardness (mg/L as CaCO_3)

Magnesium Hardness (mg/L as CaCO_3)

Total Hardness (mg/L as CaCO_3)

Iron, Total (mg/L as Fe)

Copper (mg/L as Cu)

Sodium (mg/L as Na^+)

Potassium (mg/L as K^+)

Barium (mg/L as Ba^{2+})

Strontium (mg/L as Sr^{2+})

Anions (-) attracted to Anode

p Alkalinity (mg/L as CaCO_3)

m Alkalinity (mg/L as CaCO_3)

Chloride (mg/L as Cl^-)

Silica (mg/L as SiO_2)

Sulfate (mg/L as SO_4^{2-})

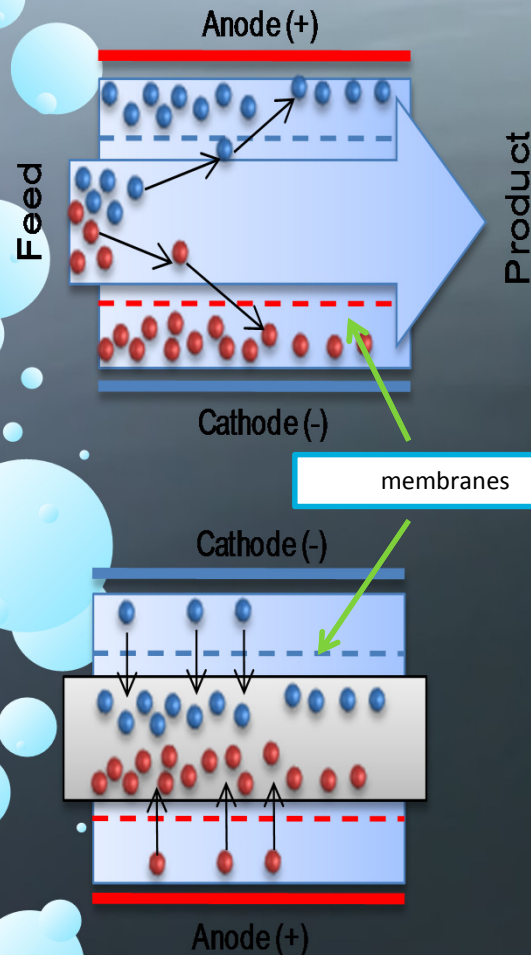
Ortho-Phosphate (mg/L as PO_4^{3-})

Total Phosphate (mg/L as PO_4^{3-})

Molybdate (mg/L as MoO_4^{2-})

How CapDI[®] works

The membrane in CapDI[®] controls efficiency and precision



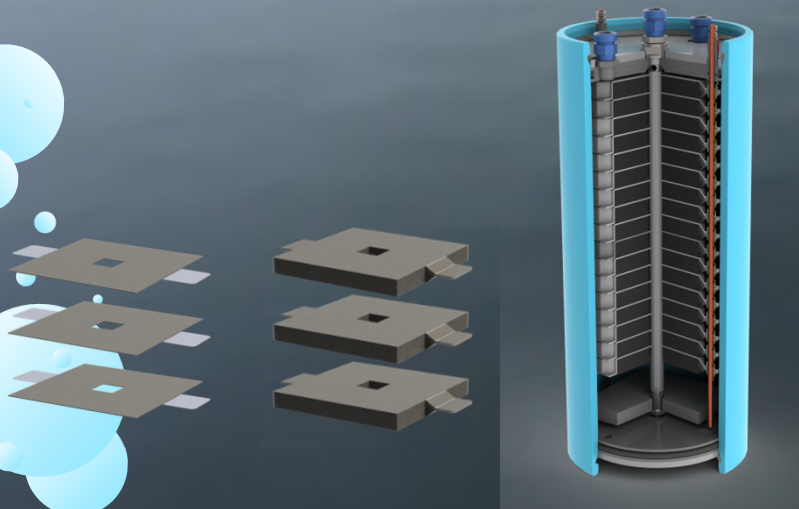
1. De-ionisation

- Water flows between the membranes
- Ions pulled through membranes and held in electrodes
- Ions with greater charge removed first
- Fresh water continues through the cells

2. Regeneration

- Flow rate is reduced and switched to waste line
- Polarity reversed on electrodes
- Ions pushed back through membranes but not across to the opposite electrodes

Seamless build: components to systems



Cells
(Membranes/
Electrodes)

Stacks

Modules



Systems

Applications

- Industrial paint rinse and protective coating bath
- Plating rinse bath recovery
- Recovery and reuse of RO reject
- Energy conscious companies who use high purity water
- Areas with restricted/tight discharge permit allowances or volume restrictions
- Industrial and commercial laundry facilities allowing them to recycle the laundry water, maintaining a low TDS and still ensuring high quality white, bright linens.
- Case specific of course - Can be used in conjunction with simple multi-media filtration to treat a fresh water source – ground, river or lake

RO Reject Recovery

Do we have a business case?

1. The driver of this RO reject project is to determine the percentage of Ro reject water consistently recovered for reuse, contribute to the Global water conservation effort all while meeting a target ROI of ~2 YEARS
2. Conductivity in well water feed ranges from 275-300 ms in the winter to 550-650 ms in the summer. Hardness around 130 ppm.
3. RO Reject on the 2200 ms range
4. Client requested pure water from CapDI in the 300 msconductivity range
5. Softening and carbon filtration prior to RO – **NO anti-scalants are being used.**
6. The RO is sized at 200 GPM. They consistently run in the 160 - 170 GPM range; ~40 GPM to be fed to CapDI.

RO Reject Recovery

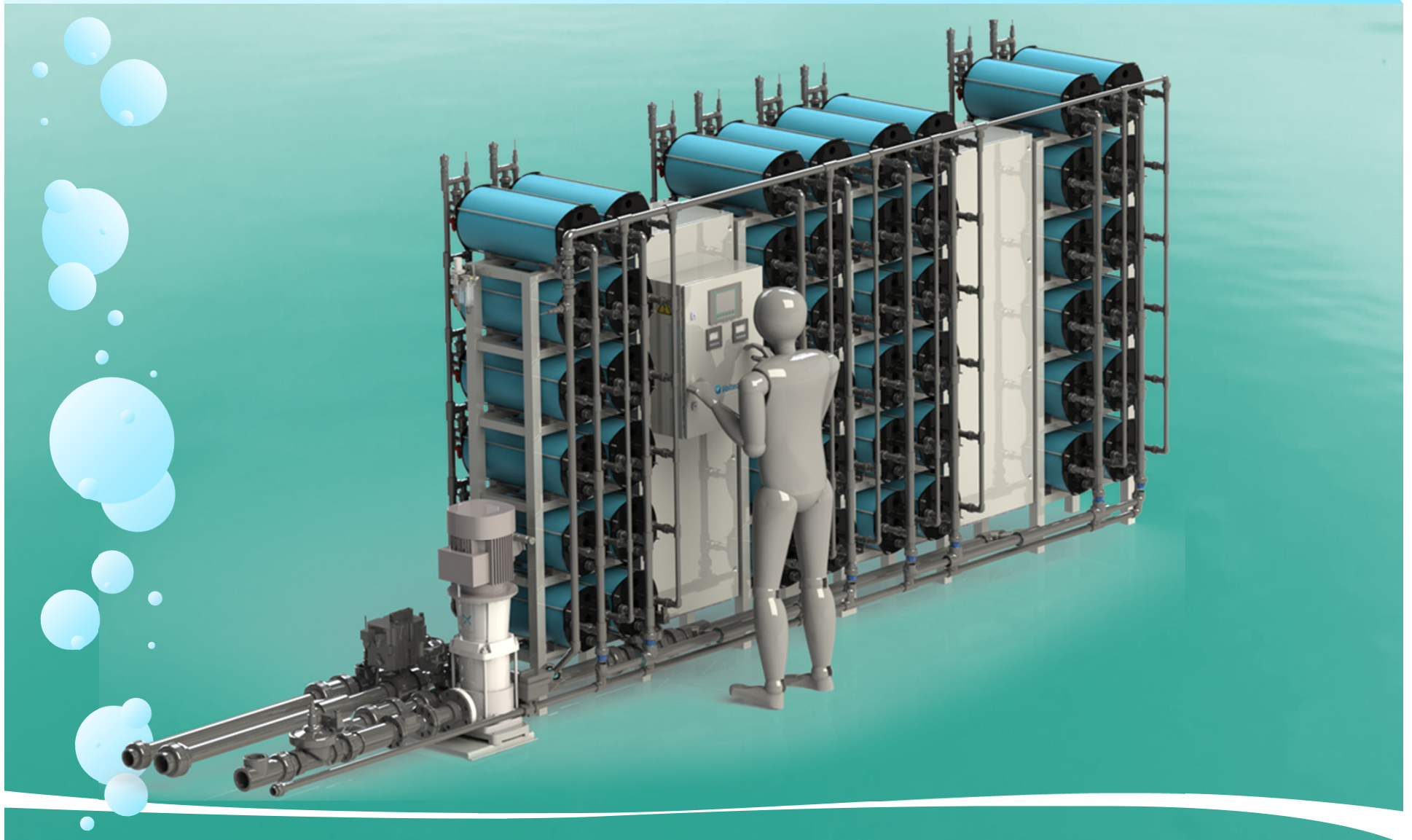
- RO feed of 160 GPM
- RO reject rate averages 25%
- GPM is assumed at avg. of 29 days
- Cost of water and sewer \$12.00 per 1,000 gallons
- CapDi demonstrated consistent recovery of 70%

RO FEED		RO REJECT at 25%		70% recovery rate	Savings at \$12.00 per 1,000 gallons
160	GPM	40	GPM	28	\$0
9,600	GPH	2,400	GPH	1,680	\$20
230,400	GPD	57,600	GPD	40,320	\$484
6,681,600	GPM	1,670,400	GPM	1,169,280	\$14,031
80,179,200	GPY	20,044,800	GPY	14,031,360	\$168,376

5 year snapshot with OPEX

	Year #1	Year #2	Year #3	Year #4	Year #5
Projected savings - 70% Recovery	\$168,376	\$168,376.32	\$168,376.32	\$168,376.32	\$168,376.32
Description					
IS 72 CapDI System	\$275,462	0	0	0	0
Engineering and Installation Estimate	\$60,000	\$0.00	\$0.00	\$0.00	\$0.00
Operating Cost					
electrical - assumes energy cost of 0.12 \$/kWh	\$7,000	\$9,000	\$11,000	\$7,000	\$9,000
CIP, maintenance and consumables	\$25,000	\$25,000	\$25,000	\$25,000	\$25,000
Module - expected 3-5 year life (Includes install, rebate and disposal but not freight)	\$0	\$0	\$0	\$170,264	\$0
O&M service agreement					
Total OPEX	\$32,000	\$34,000	\$36,000	\$202,264	\$34,000
Total System and OPEX expense	\$367,462	\$34,000	\$36,000	\$202,264	\$34,000
Cumulative cost savings	-\$199,085	-\$64,709	\$67,667	\$33,780	\$168,156
project exp/month	\$30,621.80	\$2,833.33	\$3,000.00	\$16,855.33	\$2,833.33
Savings incurred by Month	\$14,031.36	\$14,031.36	\$14,031.36	\$14,031.36	\$14,031.36
Cumulative Savings by month	-\$16,590.44	-\$5,392.41	\$5,638.95	\$2,814.98	\$14,013.00
ROI on CapDI System	19.63185065				
ROI on CapDI System and OPEX	26.18859212				

Industrial Series - IS 48



Rinse Water Reuse Application

- Rinse water feed of 46 GPM
- 21 operating days per month
- Cost of water and sewer \$17.53 per 1,000 gallons
- CapDi demonstrated consistent recovery of 82%

KO feed		82% recovery		Savings at \$17.53 per 1,000 gallons
46	GPM	38		0.6612316
2,760	GPH	2,263		39.673896
66,240	GPD	54,317		952.173504
1,391,040	GPM	1,140,653		19995.64358
16,692,480	GPY	13,687,834		239947.723

Rinse water 5 year snapshot

Paintline Rinse Recovery	1 year	2 year	3 year	4 year	5 year
Savings (82% recovery rate)	\$239,948	\$239,947.72	\$239,947.72	\$239,947.72	\$239,947.72
IS 60 CapDi system cost	\$282,614	0	0	0	0
Engineering and Installation Estimate	\$75,000	\$0.00	\$0.00	\$0.00	\$0.00
Operating Cost					
electrical - assumes energy cost of 0.12 \$/kWh	\$7,000	\$9,000	\$11,000	\$7,000	\$9,000
CIP, maintenance and consumables	\$25,000	\$25,000	\$25,000	\$25,000	\$25,000
Module - expected 3-5 year life (Includes install, rebate and disposal but no freight)	\$0	\$0	\$0	\$143,720	\$0
O&M service agreement					
Total OPEX	\$32,000	\$34,000	\$36,000	\$175,720	\$34,000
Total System, Install and OPEX expense	\$389,614	\$34,000	\$36,000	\$175,720	\$34,000
Cumulative savings	-\$149,666	\$56,282	\$296,230	\$536,177	\$776,125
project exp/month	\$32,467.80	\$2,833.33	\$3,000.00	\$14,643.33	\$2,833.33
Savings incurred by Month	\$19,995.64	\$19,995.64	\$19,995.64	\$19,995.64	\$19,995.64
cumulative cost savings by month	-\$12,472.16	\$4,690.15	\$24,685.80	\$44,681.44	\$64,677.08
ROI on system	14.13375988				
ROI on System, install and OPEX	19.48				

Similar technologies...do they really compare?

Table 1: Technology comparison

	CapDI®	RO	ED/EDR	(C)EDI	IEX Softener
Pre treatment	Low	High	Medium	High	Low
High temp system*	Yes	No	No	No	Yes
Scaling and fouling	Low	High	Medium	High	Low
Dynamic TDS adjustment	Yes	No	No	No	No
Problematic ions in feed	No	Yes	No	Yes	Yes
Chlorine tolerance	Yes	No	Yes	No	No
Chemicals	No**	Yes	Yes	Low	Salt
Consumables	Low	High	High	High	Salt
Maintenance	Low	High	High	High	Low
Energy use	Low	High	Medium	High	Low
Operational pressure	Low	High	Low	Low	Low
Water recovery	75-90%	20-75%	70-90%	90-95%	90-95%
Operation costs	\$	\$\$\$	\$\$	\$\$\$	\$\$
Price	\$\$	\$\$	\$\$\$	\$\$\$	\$

* Above 45°C/110°F.

** Acid injection may be required in some applications



Thank you

Thank you to Indiana Department of Environmental Management and the Partners for Pollution Prevention Team for the opportunity to create awareness about these sustainable technologies and respective case studies.